UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/056,944 | 01/24/2002 | Juan G. Santiago | S00-009/US | 1481 |

7590 07/12/2004

Marek Alboszta
Lumen
Suite 110
45 Cabot Ave.
Santa Clara, CA 95051

| EXAMINER | |
|---|---|
| BARTON, JEFFREY THOMAS | |
| **ART UNIT** | **PAPER NUMBER** |
| 1753 | |

DATE MAILED: 07/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/056,944 | SANTIAGO ET AL. | |
| | Examiner | Art Unit | |
| | Jeffrey T Barton | 1753 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) 1-40 is/are pending in the application.

4a) Of the above claim(s) 29-40 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-28 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 1/24.04, 3/12/02
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-28, drawn to method and apparatus for mixing by electrokinetic instability, classified in class 204, subclass 450.

   II. Claims 29-40, drawn to method of producing the apparatus for carrying out mixing by electrokinetic instability, classified in class 204, subclass 450.

The inventions are distinct from each other for the following reason:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the apparatus for carrying out the electrokinetic instability mixing can be constructed by a materially different method, such as using different substrates, dry-etching or using photolithographic patterning to form the fluidic network on the first substrate, or wet-etching the thru-holes on the second substrate.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Mr. Marek Alboszta on 01 July 2004 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-28. Affirmation of this election must be made by applicant in replying to this Office action. Claims 29-40 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

***Specification***

6. The disclosure is objected to because of the following informalities: an apparent typographical error on page 23, line 24. The impedance of the frits is reported as ~2 MΩ, when it would appear that ~2mΩ was intended.

7. Claim 21 is objected to because it appears to be incomplete, since the claim stops mid-sentence. In the following treatment, this claim is considered as though the word 'by' was deleted after the word 'chamber', and a period was inserted after the word 'chamber' in line 4. Appropriate correction is required.

***Claim Rejections - 35 USC § 102***

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

9. Claims 1, 2, and 14 are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Paul et al.

Addressing claim 1, Paul et al disclose an electrokinetic mixing method for rapid mixing (Column 2, line 19) of an initially heterogeneous solution (Column 3, lines 41-43) whose motion is dominated by viscous forces (Column 1, lines 27-34), said method comprising: inducing an electrokinetic flow instability with an AC electric field. (See Figure 1 and Column 2, line 58 - Column 3, line 20 for apparatus and flow description; AC field is described as usable in column 3, lines 21-25) This AC field acts as an active stirring means, producing a randomly fluctuating, three-dimensional fluid flow field, rapidly mixing the solution to achieve homogeneity. (Column 3, lines 15-20)

Addressing claim 2, Paul et al disclose a provided fluidic network (Figure 1) having a plurality of ports (A, B) including at least two inlet ports (A, B) and one outlet port (125), and a plurality of liquid channels connecting said plurality of ports (115, 120). Paul et al also disclose the introduction of small volume liquid streams into said fluidic network via said inlet ports (Claim 1, step b). These liquid streams are characterized as confluent, as they meet within chamber 110, and they form the heterogeneous solution that is to be mixed. (Claim 1, steps b and c)

Addressing claim 14, Paul et al disclose the generation of a homogeneous solution from a fixed volume of heterogeneous solution without net flow. (Column 3, lines 27-32)

10. Claims 1, 2, and 15 are rejected under 35 U.S.C. 102(e) as being anticipated by Ahn et al.

Addressing claim 1, Ahn et al disclose an electrokinetic mixing method for rapid mixing of an initially heterogeneous solution (Paragraphs 0010 and 0011) whose motion is dominated by viscous forces (Microfluidic devices typically operate in this regime - low velocities, small length scales.), said method comprising: inducing an electrokinetic flow instability with an AC electric field. (Paragraphs 0050, 0062-0064) This AC field acts as an active stirring means, producing a randomly fluctuating, three-dimensional fluid flow field, rapidly mixing the solution to achieve homogeneity. (Paragraphs 0003, 0050)

Addressing claim 2, Ahn et al disclose a provided fluidic network (Figure 1) having a plurality of ports (20, 24, 28) including at least two inlet ports (20, 24) and one outlet port (28), and a plurality of liquid channels connecting said plurality of ports (22). Ahn et al also disclose the introduction of small volume liquid streams into said fluidic network via said inlet ports (Paragraphs 0049 and 0087). These liquid streams are characterized as confluent, and they form the heterogeneous solution that is to be mixed. (Abstract)

Addressing claim 15, Ahn et al disclose the mixing of fluids containing biological macromolecules. (Paragraphs 0004 and 0006)

### *Claim Rejections - 35 USC § 103*

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

12. Claims 3-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al in view of Bek.

Ahn et al disclose a method as described above for claim 2.

Relevant to claim 4, Ahn et al further disclose a plurality of side channels along the main flow channel (Figure 1, reservoirs 24 and connecting channels)

Relevant to claim 5, Ahn et al further disclose a mixing chamber, characterized as the space within the channel lying between the electrodes used to apply the AC field. (Figures 3-7)

Relevant to claim 6, Ahn et al further disclose the use of porous dielectric membranes within the channels. (Paragraph 0054) Whether these membranes have high flow resistance would be a matter of selection based on the particular application, and they are disclosed as preventing passage of interfering materials (Paragraph 0054). Numerous disclosed materials would not interfere with passage of the AC field. (Paragraph 0054)

Relevant to claim 8, Ahn et al further disclose continuous-flow mixing. (Paragraph 0087)

Ahn et al do not explicitly disclose the positioning of the electrodes used to deliver the AC field in ports at the ends of side channels within the fluidic network. (Claims 3 and 5) They also do not disclose the AC mixing field being disposed axially along a fluid flow path (claim 4), or the specific method of causing flow from inlet to outlet within their system. (Claim 7)

Bek discloses a method of mixing fluids within capillaries in which the electric field that causes mixing is applied from capillary ends at a distance from the location where mixing occurs. (Figure 1, Abstract) Bek also discloses the use of electroosmosis to effect fluid flow. (Column 3, lines 37-47)

Ahn et al and Bek are analogous art in that both address the problem of mixing fluids within capillary systems.

Addressing claims 3-5, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the invention of Ahn et al by positioning the electrodes used to apply the AC field in ports at the ends of side channels (e.g. in leftmost reservoirs 24 of Figure 1), as taught by Bek, because it would isolate the samples from potential electrolysis products associated with the method of Ahn et al. (Paragraph 0093) This configuration would result in the AC field being axially oriented along the main flow channel, parallel to the fluid flow.

Addressing claim 6, it would have been obvious to configure the combination of Ahn et al and Bek by positioning the filters/membranes already disclosed by Ahn et al in the channels connecting the ports used for the AC electrodes and the sample-containing channel, because it would further help to isolate the samples from potential electrolysis products associated with the method of Ahn et al. (Paragraph 0093)

Addressing claim 7, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the combination of Ahn et al and Bek already described above by providing fluid flow (i.e. from reservoirs 20 and 24 to outlet port 28)

by using electroosmosis, as also taught by Bek, because it is known to be a convenient method of effecting fluid flow in microfluidic devices.

Addressing claim 8, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Ahn et al by providing fluid flow (i.e. from reservoirs 20 and 24 to outlet port 28) by using electroosmosis, as taught by Bek, because it is known to be a convenient method of effecting fluid flow in microfluidic devices.

13. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Paul et al in view of Bek.

Paul et al disclose a method as described above for claim 2. They also disclose the ability to use their mixing method both continuously and with stopped flow. (Column 3, lines 27-35)

Paul et al do not explicitly disclose the means used to achieve fluid flow from inlet to outlet.

Bek discloses the use of electroosmotic forces to effect fluid motion in his capillary system. (Column 3, lines 37-47)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Paul et al by using electroosmosis to provide fluid flow, as taught by Bek, because it is known to be a convenient method for effecting fluid flow in microfluidic devices.

14. Claims 9, 11, and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al in view of Bek.

Ahn et al disclose a method as described above for claims 1 and 2. They also suggest the modification of the electric fields used in their method, including pulsed current and use of AC and DC. (Paragraph 0065)

Ahn et al do not explicitly disclose the means used for fluid transport from the reservoirs to the outlet. They also do not explicitly disclose the use of a steady DC field or pressure source for liquid stream advection in addition to the mixing AC electric field (Claim 9), nor do they disclose pulse modulation between AC for mixing and DC for transport (Claim 11), or the addition of a steady DC component for transport simultaneous with the AC electric field (Claim 12).

Bek discloses the use of electroosmotic forces caused by an applied DC field to effect fluid motion in his capillary system. (Column 3, lines 37-47)

Relevant to claims 9, 11, and 12, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Ahn et al by using a DC field to provide electroosmotic flow, as taught by Bek, because it is known to be a convenient method for effecting fluid flow in microfluidic devices.

Addressing claims 9 and 12, it would also have been obvious to provide this DC field simultaneously with the AC mixing field, because it would allow for continuous-flow mixing as described in Ahn et al. (Paragraph 0087)

Addressing claim 11, it would also have been obvious to provide pulses of AC and DC current in such a way that the flow rates and mixing properties were optimized, because Ahn et al suggested such optimization. (Paragraph 0065)

15. Claims 9, 11, and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Paul et al in view of Bek.

Paul et al disclose a method as described above for claims 1 and 2. They also suggest the modification of the electric fields used in their method, including oscillation and use of varying period. This suggests the use of alternating current. (Column 3, lines 21-25)

Paul et al do not explicitly disclose the means used for fluid transport from the reservoirs to the outlet. They also do not explicitly disclose the use of a steady DC field or pressure source for liquid stream advection in addition to the mixing AC electric field (Claim 9), nor do they disclose pulse modulation between AC for mixing and DC for transport (Claim 11), or the addition of a steady DC component for transport simultaneous with an AC electric field (Claim 12).

Bek discloses the use of electroosmotic forces caused by an applied DC field to effect fluid motion in his capillary system. (Column 3, lines 37-47)

Relevant to claims 9, 11, and 12, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Paul et al by using a DC field to provide electroosmotic flow from inlet to outlet, as taught by Bek, because it is known to be a convenient method for effecting fluid flow in microfluidic devices.

Addressing claims 9 and 12, it would also have been obvious to provide this DC field simultaneously with an AC mixing field, because it would allow for continuous-flow mixing, as described by Paul et al. (Column 3, lines 32-35)

Addressing claim 11, it would also have been obvious to provide pulses of AC (mixing) and DC (flow-inducing) current, because it would allow for optimization of flow rate and mixing efficiency.

16. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al.

Ahn et al disclose a method as described above for claim 1. They also disclose the use of porous dielectric membranes within the channels. (Paragraph 0054) These membranes (or filters) are disclosed as preventing passage of interfering materials (Paragraph 0054). Numerous disclosed materials would not interfere with passage of the AC field, and the combination of their porosity with the use of electrolyte fluids (Abstract) renders them conductive.

Ahn et al do not explicitly disclose the use of high flow resistance in the membranes they use.

It would have been obvious to one of ordinary skill in the art to modify the method of Ahn et al by replacing their membranes with membranes of high flow resistance, because it could be required by the demands of a particular research problem.

17. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al in view of Wilding et al.

Ahn et al disclose a method as described above for claim 1.

Ahn et al do not explicitly disclose the means used to achieve fluid flow from inlet to outlet.

Wilding et al disclose the use of a micropump to effect fluid motion in their capillary system. (Figure 4; Column 9, lines 38-42)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Ahn et al by using a micropump to provide fluid flow, as taught by Wilding et al, because it would prevent possible electrical interference or electrolysis due to application of a DC field.

18. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Paul et al in view of Wilding et al.

Paul et al disclose a method as described above for claim 1.

Paul et al do not explicitly disclose the means used to achieve fluid flow from inlet to outlet.

Wilding et al disclose the use of a micropump to effect fluid motion in their capillary system. (Figure 4; Column 9, lines 38-42)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Paul et al by using a micropump to provide fluid flow,

as taught by Wilding et al, because it would prevent possible electrical interference or electrolysis due to application of a DC field.

19. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al in view of Yager et al.

Ahn et al disclose a method as described above for claim 1. They also suggest the use of various sensors to monitor performance of their system. (Paragraph 0055)

Ahn et al do not explicitly disclose the use of means for analysis of mixing performance.

Yager et al disclose the monitoring of mixing efficiency in their microfabricated system. (Figure 2; Column 7, lines 1-6)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Ahn et al by including a sensor to monitor mixing efficiency, as taught by Yager et al, because it was suggested by Ahn et al, and would allow for precise optimization of operating parameters.

20. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Paul et al in view of Yager et al.

Paul et al disclose a method as described above for claim 1.

Paul et al do not explicitly disclose the use of means for analysis of mixing performance.

Yager et al disclose the monitoring of mixing efficiency in their microfabricated system. (Figure 2; Column 7, lines 1-6)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Paul et al by including a sensor to monitor mixing efficiency, as taught by Yager et al, because it would allow for precise optimization of operating parameters.

21. Claims 17, 18, 20-22, 26, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al in view of Bek.

Relevant to claim 17, Ahn et al disclose a micromixer, comprising a fluidic network (Figure 1) having: a mixing chamber, characterized as the space within the channel lying between the electrodes used to apply the AC field (Figures 3-7); a plurality of ports (20, 24, 28) including at least two inlet ports (20, 24), two side channel ports (24), an outlet port (28), and a plurality of liquid channels connecting the mixing chamber and plurality of ports (22); and one or more porous dielectric membranes. (Paragraph 0054) Whether these membranes have high flow resistance would be a matter of selection based on the particular application. Ahn also discloses the use of an AC electric field across the mixing chamber to effect mixing of a heterogeneous solution, rendering it homogeneous. (Paragraph 0050)

Relevant to claim 18, Ahn et al disclose electrically conductive buffer positioned in the side channel ports (24) (Paragraphs 0052, 0055, and 0056)

Relevant to claim 20, Ahn et al disclose modulation (pulsing) of AC and DC fields, implicitly including means of causing such modulation. (Paragraphs 0063-0065)

Relevant to claim 22, Ahn et al disclose a continuous mixing mode. (Paragraph 0087)

Relevant to claim 26, Ahn et al disclose the mixing of a solution containing biological macromolecules (Paragraph 0004)

Relevant to claim 28, Ahn et al disclose a micromixer with no moving parts (Paragraph 0009), utilized in a bioanalytical system. (Paragraph 0004)

Ahn et al do not explicitly disclose the positioning of the electrodes that apply the AC field in ports at the ends of side channels (Claim 17). Nor do they disclose the use of DC-driven electroosmotic flow of fluids from inlet to outlet. (Claims 20-22)

Bek discloses a method of mixing fluids within capillaries in which the electric field that causes mixing is applied from capillary ends at a distance from the location where mixing occurs. (Figure 1, Abstract) Bek also discloses the use of DC-driven electroosmotic flow. (Column 3, lines 37-47)

Addressing claim 17, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the invention of Ahn et al by positioning the electrodes used to apply the AC field in ports at the ends of side channels (e.g. in reservoirs 24), as taught by Bek, because it would isolate the samples from potential electrolysis products associated with the method of Ahn et al. (Paragraph 0093)

Further addressing claim 20, it would have also been obvious to one of ordinary skill in the art at the time of the invention to modify the invention of Ahn et al by

providing modulation between AC mixing field and the DC transport field taught by Bek, because such modulation was suggested by Ahn et al (Paragraphs 0063-0065) and it would allow for optimization of flow rate and mixing efficiency.

Further addressing claims 21 and 22, it would have also been obvious to one of ordinary skill in the art at the time of the invention to modify the invention of Ahn et al by providing (simultaneously with the AC mixing field) a steady DC field to effect electroosmotic transport towards the mixing chamber, as taught by Bek, because it would allow for continuous-flow mixing, as described by Ahn et al (Paragraph 0087).

22. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al and Bek as applied to claim 17 above, and further in view of Laugharn, Jr. et al.

Ahn et al and Bek disclose a combination as described above for claim 17.

Neither Ahn et al nor Bek explicitly disclose the external attachment of membranes to ports in their systems.

Laugharn, Jr. et al disclose the mounting of a membrane external to their microfluidic chip. (Column 11, lines 38-44)

Ahn et al, Bek, and Laugharn, Jr. et al are analogous art because all describe improvements in microfluidic devices.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the device of Ahn et al by replacing their membranes with externally mounted membranes, as taught by Laugharn, Jr. et al, because it would facilitate cleaning and/or replacement of the membranes.

23. Claims 23 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al and Bek as applied to claim 17 above, and further in view of Wilding et al.

Ahn et al and Bek disclose a combination as described above for claim 17.

Neither Ahn et al nor Bek explicitly disclose the use of a pressure-source means for providing fluid flow.

Wilding et al disclose the use of a micropump to effect fluid motion in their capillary system. (Figure 4; Column 9, lines 38-42)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the combination of Ahn et al and Bek by using a micropump to provide fluid flow, as taught by Wilding et al, because it would prevent possible electrical interference or electrolysis due to application of a DC field.

24. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al and Bek as applied to claim 17 above, and further in view of Paul et al.

Ahn et al and Bek disclose a combination as described above for claim 17.

Neither Ahn et al nor Bek explicitly disclose mixing with stopped fluid flow.

Paul et al disclose the use of a microfluidic mixer that is capable of mixing fluids in the absence of net fluid flow. (Column 3, lines 27-32)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the combination of Ahn et al and Bek by stopping the bulk flow of

liquid into and out of the mixing chamber during mixing, as taught by Paul et al, because it would allow for more thorough mixing prior to discharge of the solution.

25. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al and Bek as applied to claim 17 above, and further in view of Yager et al.

Ahn et al and Bek disclose a combination as described above for claim 17. Ahn et al also suggest the use of various sensors to monitor performance of their system. (Paragraph 0055)

Neither Ahn et al nor Bek explicitly disclose the use of means for analysis of mixing performance.

Yager et al disclose the monitoring of mixing efficiency in their microfabricated system. (Figure 2; Column 7, lines 1-6)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the combination of Ahn et al and Bek by including a sensor to monitor mixing efficiency, as taught by Yager et al, because it was suggested by Ahn et al, and would allow for precise optimization of operating parameters.

***Conclusion***

26. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Zare et al disclose a barrier frit in a capillary wall that prevents fluid flow while allowing electrical conduction.

27. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey Barton, whose telephone number is (571) 272-1307. The examiner can normally be reached Monday-Friday from 8:30 am – 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen, can be reached at (571) 272-1342. The fax number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at (866) 217-9197 (toll-free).

JTB
July 2, 2004

NAM NGUYEN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700